Reflections on using the blockchain for logistics and supply chain management.

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Full Paper

Abstract: In an environment characterized by far-reaching digital mutations, connected objects, big data, platforms, etc., blockchain technology may lead to profound changes in the management of the logistics chains. This raises the question of the potentialities of such an innovative technology for logistics and, more generally, for SCM and its principles for managing flows and processes. This article proposes a forward-looking viewpoint on the uses of this technology for logistics and Supply Chain Management.

Key-words: Digitalization, Blockchain, Supply Chain Management

Approximately 25 years ago, Bowersox and Daugherty (1995) predicted that systems and technologies for processing and disseminating information would largely influence the evolution of logistics-function paradigms.

These tools have clearly played an important role in the emergence of supply chain management. Indeed, they have allowed the integration and acceleration of information flows (customer/supplier interfaces, or flows between forecasts, stocks and planning, for example) and provided solutions enabling global management of the supply chain: supply, production, distribution, demand. Drawing on Bayraktar et al., (2009), we may cite the following IT/ST: "extended enterprise" models, such as Enterprise Resources Planning (ERP), which make it possible to manage all transactional information within and across organizations; integration models, such as supply chain planning tools, whose objective is to provide decision support in the supply chain; and facilitators, which are complementary to the models mentioned and whose role is to enable and accelerate the dissemination and processing of information between partners.

The emergence of modern solutions is raising new questions about the functioning of logistics and supply-chain management. This is particularly true of the blockchain, as a recent review has shown (Wang et al., 2019). The blockchain may be defined as "transparent technology for storage and transmission, which operates without a central control device" and uses "a tamper-proof digital database on which all exchanges between its users are recorded" (Blockchain France, 2016). Its key promise is to create transparency (Tapscott, Tapscott, 2017), which is one of the most important and complex aspects of improvements to logistics and supply chain management (Abeyratne, Monfared, 2016). Not surprisingly, several logistics experts consider the blockchain to offer "enormous potential" (O'Marah, 2017), to be an "indispensable platform for economic renewal" (Casey and Wong, 2017), or to act as an "essential platform for transforming the supply chain and disrupting the way we produce, market, buy and consume our products"(Dickson, 2016) This article proposes a forward-looking viewpoint (Scouarnec, 2008) on the uses of this technology for logistics. After describing how it works (1), we will present the methodology (2) and apply it to the various logistics and supply chain management activities (3).

1. Blockchain technology

1.1. Characteristics and operating principles

Blockchain is primarily based on distributed ledger technology[1]. This ledger requires a peer-to-peer network and consensus algorithms to ensure synchronization and authentication across nodes. The ledger is presented in the form of a chain of blocks commonly referred to as "blockchain". While the blockchain is not the only form of distributed ledger technology[2], it is the most common form among cryptocurrencies from which the industrial applications discussed in this article are drawn. The distributed structure of the blockchain provides additional security compared with traditional "client-server" architectures (Gatti et al., 2004 ; Baran, 2011).

The blocks are arranged according to numbers referred to as hashes[3]. It is impossible to invert the blocks because each block bears the hash number of the previous block. The model below, proposed by Desplebin et al. (2018), summarizes how this network works (Figure 1).

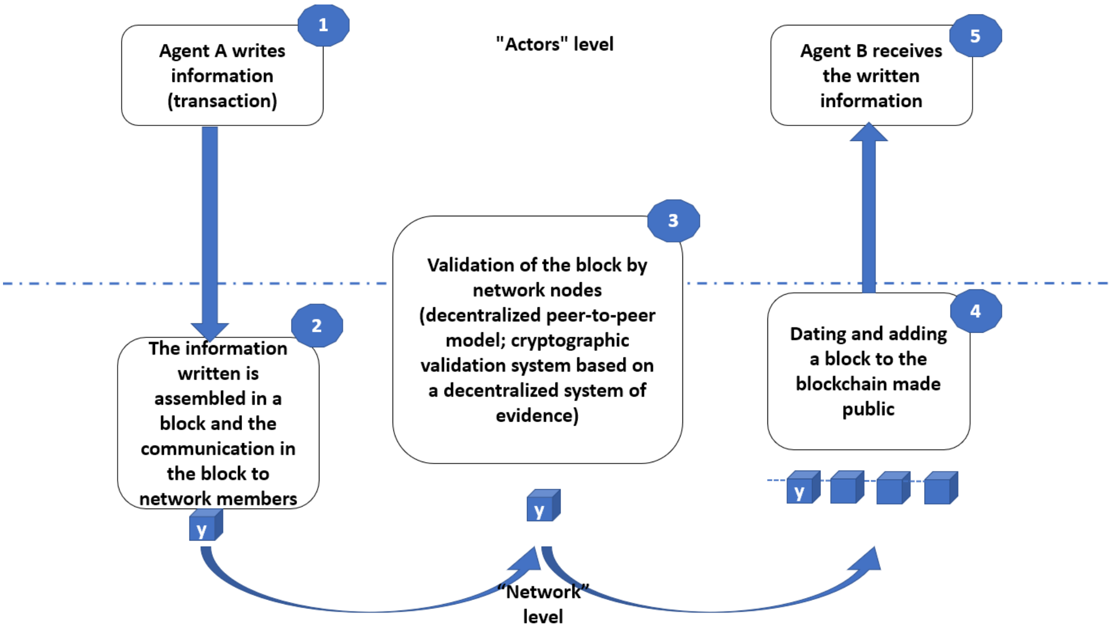

Figure 1: How the blockchain network functions. Source: Desplebin et al., 2018; 2019.

[1] A distributed ledger is a transaction log that is stored and synchronized across a computer network.

[2] Given that no clear classification has been defined to date, we use the term "blockchain" to refer interchangeably to blockchains and to the more global terms of distributed ledger technologies (DLTs) and distributed registry technologies.

[3] The hash function, derived from the English word "hash", which means cutting into small pieces and mixing, is used to calculate a unique numeric fingerprint from input data.

The blockchain also requires a consensus algorithm which enables the establishment of trust (the literature often refers to the term "trust machine" in reference to the blockchain (The Economist, 2015). The consensus mechanism seeks to obtain an agreement on the historical state of transactions and to function without a central entity.

The addition of smart contracts has made it possible to apply complex business logic to the blockchain. A smart contract is a set of codes and data (sometimes referred to as functions and states) used in a blockchain, which enables users to perform calculations, store information and automatically send funds to other accounts (Yaga et al., 2018). Smart contracts have not only helped to introduce the *blockchain* into the set of industrial management tools, they have also proposed an additional feature, i.e., the automation of control calculations. Indeed, they can effectively trigger order-type processes after parts are ordered and ensure that the parts produced show compliance with the requirements (Yaga et al., 2018). They thus allow a complex business logic to be applied to the blockchain.

Lastly, it should be noted that, beyond the technical aspects, two types of blockchain may be distinguished: public or permissionless, and private or permissioned. In a private/permissioned blockchain, only certain participants can join the peer-to-peer network. A small group of actors may access, verify and add transactions to the ledger. Moreover, it is possible to limit access to certain information to a few participants (Lewis et al., 2017). Because manufacturers privilege private blockchains, this study will focus on this type of blockchain.

1.2. The evolution of the blockchain and the main issues encountered.

Since the creation of the first blockchain in 2008, with Bitcoin, several developments have led to changes in how the blockchain is used. These developments may be divided into three main phases: Blockchain 1.0 for digital currency, Blockchain 2.0 for digital finance and supply chain management and Blockchain 3.0 for the digital society.

Blockchain 1.0 regroups all cryptocurrencies. These blockchains were the first digital assets that emerged as a logical extension of the famous Bitcoin.

In 2014, the addition of smart contracts made it possible to use the blockchain for non-financial applications, particularly with regard to the supply chain. As a result, several blockchains shifted away from cryptocurrencies and began to address manufacturers directly. These applications, using smart contracts, all fall within the second-generation blockchain referred to as Blockchain 2.0.

Blockchain 3.0 goes beyond the confines of the business sector and even the home sector. “Decentralized autonomous organizations” (DAO) is a term commonly used in reference to this blockchain. For clarity purposes, we will refer to inter-firm organization. Blockchain 3.0 introduced the concept of decentralized applications and computing (Della Chiesa et al., 2018). This requires the partial sharing or outsourcing of activities that would otherwise be handled by the coordinating mechanism. It changes the more traditional type of transaction structure and generally requires changes to the governance structure because the services provided, and the underlying support functions, are not under the direct control of the central agency. The change in organizational boundaries makes it possible to adapt different operating modes in order to generate value, with a focus on the relationship between physical and financial flows. Generally speaking, one may use Blockchain 3.0 terminology when several firms use a decentralized application (DApp) to exchange value.
The evolution of the blockchain can be summarized as follows (Figure 2):

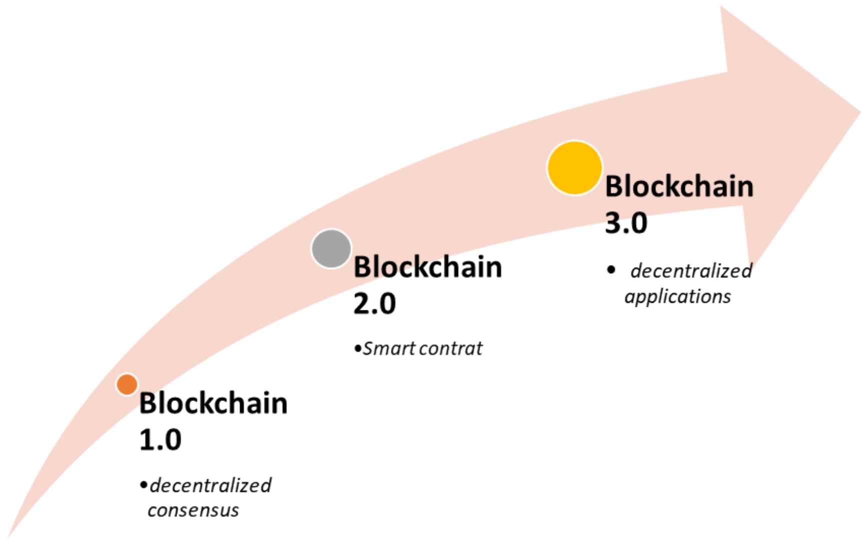

Figure 2: Evolution of the blockchain. Source: Angelis, Ribeiro da Silva, 2018

These three developments all call for reflection on the future of professions in the field of logistics and supply chain management and in this sector as a whole. After presenting our methodology, we will provide an in-depth discussion on the blockchain.

1.3. The current limits of the Blockchain

Before considering the possible uses of the Blockchain in Logistics and Supply Chain Management, we must make it clear that the Blockchain itself is not without limits. These limits are at once technological, economic, legal and governance-related.

Let’s consider the technological aspect, first. To date, there is no universal blockchain protocol (Roubini, 2018) and in addition distributed registries are developing all over the world on many applications while there is no sign of the emergence of a common protocol yet. Moreover, the maturity of smart contracts itself is being questioned; currently there are certain flaws in the security of smart contracts and these have had a strong impact on the blockchain developer community (Eustache, 2016).

Secondly, the legal side: smarts contracts raise various questions (Barraud, 2018; Sklaroff, 2017): does a brand have the right to impose a computer program on its suppliers to control working conditions or the origin of raw materials? And who would own the smart contract thus created?

Finally, in terms of governance, the very notion of removing the trusted third party is not identical for all blockchains. Sometimes it is precisely a question of strengthening the power of the trusted third party. For example, in the retail sector, the Walmart group has forced some of its suppliers to adopt the blockchain under threat of deregistration; we are far from the image of the abolition of a centralizing third party.

It seems to us that some of these limits can be overcome. In particular, it is likely that the technological problems that are hampering the development of the Blockchain will be resolved in a few years' time. Others will be more difficult to resolve in the short term, notably the difficulties related to governance, which currently constitute the main stumbling block to the adoption of the Blockchain; indeed, certain problems in the constitution of the ecosystem will remain significant, since this is a revolution in a system rather than a change in technology (Christensen, 2016).

Beyond these limits, the evolutions of the Blockchain represent as many elements of reflection for the prospective of the professions and the sector of logistics and Supply Chain Management. After a presentation of the methodology, we shall develop reflection on the Blockchain.

2. Methodology: a forward-looking reflection

In order to discuss the impacts of the blockchain in the field of logistics and supply chain management we conducted a literature review and a "prospective activity" (Bootz, 2005) which relies on encounters and discussions with blockchain experts, notably via interviews, studies undertaken within the Talan company and reflections during conferences (professional conferences: Bpifrance Inno Generation 2018 Fair, West Data Festival 2019, VivaTech 2019, Blockchain Forum 2018, 2019 and Dumont d'Urville encounters 2019 (The Blockchain ROI, 2019) and hackathons (Africa Blockchain Summit 2018, Hackathon Blockchain and Shop 2018).

Due to recent academic developments on this topic, our literature search included both academic works and professional reports and publications of major firms or professional associations and orders. The latter documents have greatly contributed to the reflection developed here, particularly with regard to the impact on professions. Because of the innovative nature of the subject, the bibliographical research was deliberately broad. The oldest result is dated 2015. Many results were excluded mainly because they were out of scope or because the source appeared unreliable, i.e. a source other than an academic journal, a generalist reference journal or a document produced by a major auditing firm or a recognised association or professional order. In addition, in the grey literature, redundant publications were eliminated. The sorting of results was confirmed by using a "snowball" search (article cited by and citing) starting with the references considered most significant at present (number of citations).

In order to bring out discussion themes on the technical and professional stakes of the blockchain, we coded them according to the principles of the Eisenhardt Template (Eisenhardt, 1989). The analysis conducted is based on the following steps. Empirical data (articles and discussions with blockchain experts) were classified using the SCM model and integrate the logistical flows proposed by Mentzer et al. (2001, Figure 3). This approach made it possible to describe both the processes for creating these different dimensions and the conditions for their implementation. Our approach is therefore based on hypothetical-deductive logic based on the SCM model (Figure 1).

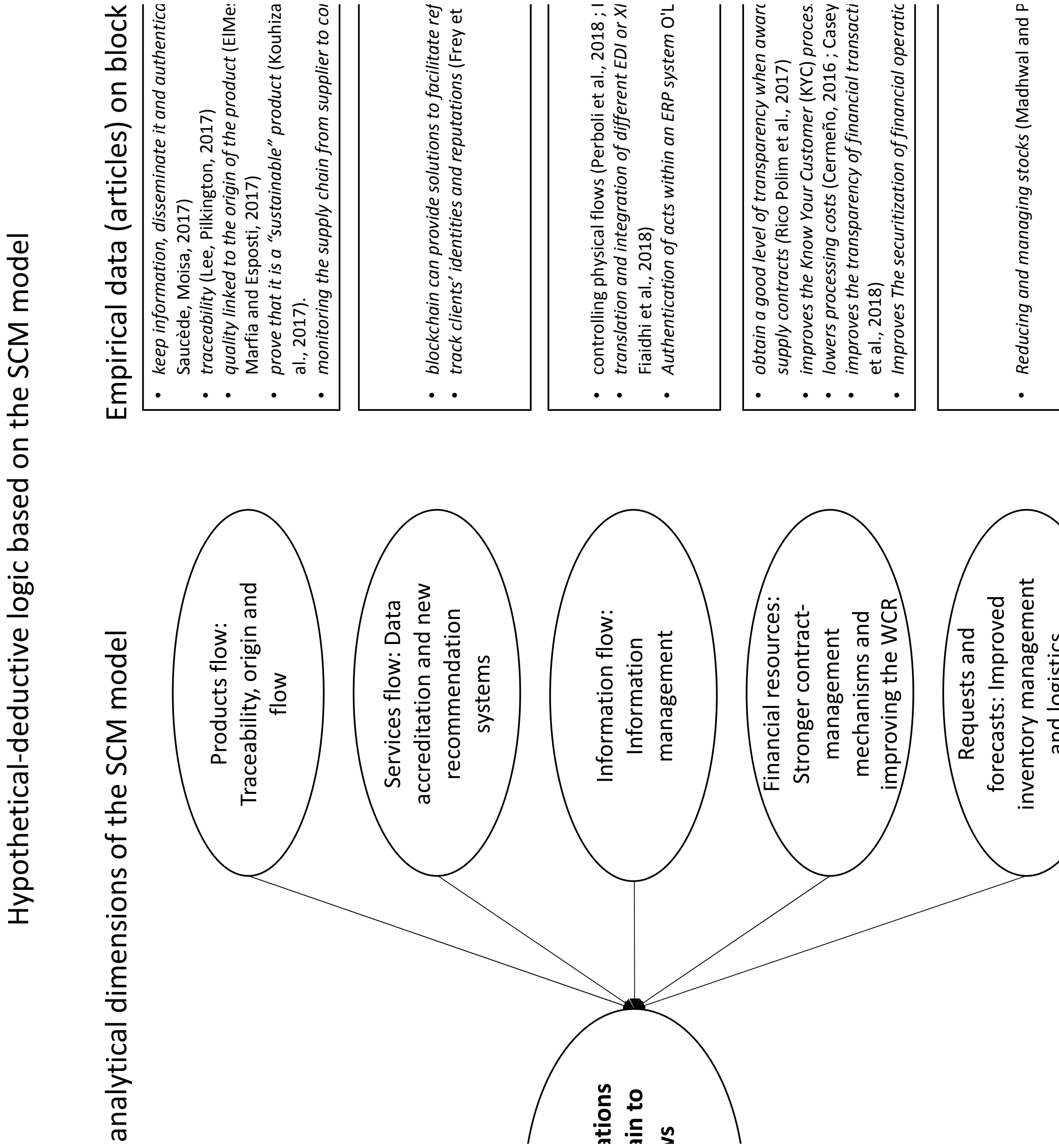

Figure 3: Hypothetical-deductive logic based on the SCM model

On the basis of these results, we have carried out a reflection draws on a specific prospective-employment evaluation approach developed by (Boyer and Scouarnec, 2002; 2005), which notably seeks to identify possible scenarios in terms of changes in employment and, more generally, the most probable future scenarios that companies will face: "It is thus a question of imagining the consequences of these trends on real work situations and on the organization of work and professions" (Mérindol et al., 2009). Scouarnec (2008), defines a prospective approach as "a reflection on the possible futures and one that is based on an appropriate methodological approach (...). Forward-thinking involves anticipating, even imperfectly, changes, discontinuities, eventualities. (...)". (Desplebin et al., 2018), citing the studies undertaken by (Hatem and Préel, 1995), reveal the five characteristics of a prospective approach: global, long-term, rational, enabling appropriation and providing a vision for action. Our approach, which attempts to understand the effects of the blockchain in the field of logistics and supply-chain management (SCM), meets all these characteristics. It is, therefore, a global approach because its objective is to identify the business/process impacts in this field. We have also adopted a long-term reflection which seeks to anticipate changes that are currently being launched and also those, representing the majority, in the project phase. Our approach is rational because it relies on the statements made by blockchain experts and on the logistics issues encountered by the authors. It also draws on the reflection of expert authors (two are specialists in logistics and two specialize in blockchains) and on observations of concrete practices on the ground (one of the authors works for an organization that focuses on logistics and SCM)

3. Reflections on using the blockchain in the field of logistics and SCM

In an environment characterized by far-reaching digital mutations, connected objects, big data, platforms, etc. (Korpela et al., 2017 ; Straube, Junge, 2017 ; Porter, Heppelmann, 2014), the blockchain may lead to profound changes in the management of the logistics chain (Perboli et al., 2018 ; Kshetri, 2018). More precisely, the blockchain, which is a distributed digital ledger decentralizing data-sharing and ensuring the storage and transmission of information in a secure manner without the need for a supervisory authority, may notably enable users to secure exchanges throughout the logistics chain and allow better coordination among actors and improved traceability and even reduce the number of intermediaries within the blockchain (Hug, 2017 ; Kin et al., 2018). This raises the question of the potential of such an innovative technology for logistics and, more generally, for SCM and its principles for managing flows and processes (Fabbe-Costes and Jahre, 2008 ; Vichara Kin et al., 2018).
To highlight the possible impact of the blockchain on these elements, we will use the SCM model and integrate the logistical flows proposed by Mentzer et al. (2001, Figure 3). Indeed, as Estampe and Balai (2016) argue, this model serves as a frame of reference to guide all the reflections around SCM and therefore seems relevant to our purpose. It represents the ultimate purpose of SCM (creating value for the client, gaining a competitive advantage, reducing costs, etc.), the various flows that circulate between the actors of the extended chain (products, services, etc.), the functions involved in the coordination and flow-management process, the conditions for interfunctional coordination (trust, commitment, risk, dependence

and functioning) and the boundaries of the different systems that help to structure the supply chain.

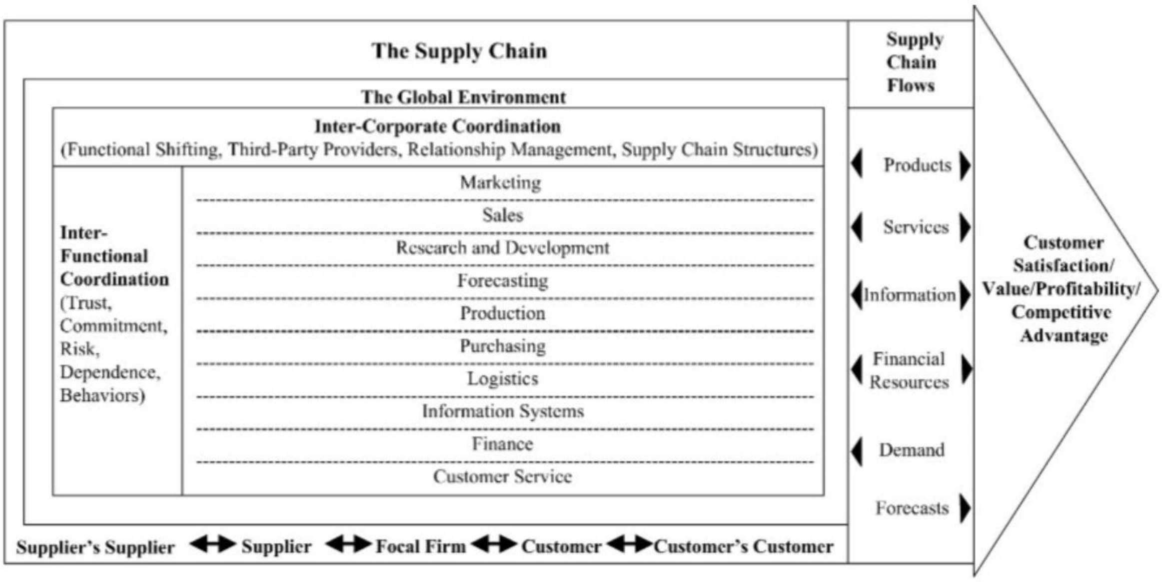

Figure 4: Mentzer's definition of SCM (Mentzer et al., 2001)

In the following sections, we will analyze the consequences of the blockchain on logistic flows (3.1) and then assess its impact on the coordination between actors and on collaborative practices (3.2).

3.1. Possible applications of the blockchain to logistic flows

In this section, we discuss the possible applications of the blockchain according to the different flow categories of the logistics model proposed by Mentzer et al. (2001): Products, Services, Information, Financial Resources, Requests and Forecasts.

3.1.1. Products flow: Traceability, origin and flow

The term traceability refers to the ability to track and trace a product. Three key components may be distinguished: upstream tracking, downstream tracking and historical information related to products as they move along the supply chain (Viruéga, 2005 ; Fabbe-Costes, 2005 ; Bosona and Gebresenbet, 2013).

These three types of information are intrinsically linked in a blockchain. The use of the blockchain to support traceability thus appears as an effective and safe method to keep information, disseminate it and authenticate it (Apte, Petrovsky, 2016 ; Saucède, Moisa, 2017).

With regard to upstream traceability, applications in the food industry reveal the origin of a product (Lee, Pilkington, 2017). Moreover, several quality labels rely on information provided by a blockchain to confirm the quality linked to the origin of the product (ElMessiry and ElMessiry, 2018 ; Marfia and Esposti, 2017), or to prove that it is a “sustainable” product (Kouhizadeh and Sarkis, 2018 ; Beck et al., 2017).

Regarding downstream traceability, there are many examples of a blockchain's performance in dealing with product returns, as illustrated by the case of the Wallmart mangoes, or in monitoring the supply chain from supplier to consumer (Toyoda et al., 2017). This is particularly the case in the field of ultra-fresh products where the best-before date of food products must be verified at their reception in distribution centers.

Lastly, the hashing algorithms in the blockchain may allow more accurate traceability and its generalization may take into account the entire supply chain.

3.1.2. Services flow: Data accreditation and new recommendation systems

While customer service is provided by all the company’s functions, logistics is likely to propose a set of services (availability, deadlines, reliability of deadlines, etc.) that make it possible to differentiate between products and to provide greater value to a customer consuming an increasing number of services, as the development of e-commerce has shown

(Nguyen and Chanut, 2018 ; Baranger et al., 2016 ; Dornier and Fender, 2007). The information provided by logistics thus plays a fundamental role in customer satisfaction, notably in terms of inventory management, collateral management and recommendation systems.

In terms of inventory management, we refer in particular to the Vendor Managed Inventory (VMI) system set up between manufacturers and suppliers to optimize their functioning. This system involves, in particular, sharing information on sales and on the quantities remaining in stock. When using private blockchains, these data may be accredited by all the actors of a consortium and by the smart contracts process. We believe that this may allow cheaper and safer operations compared with the installation of an ERP chain. To certify input data, which is an important issue today, these private blockchains could be associated with other technologies such as the Internet of Things in automated systems, or consistency control through artificial intelligence.

With respect to guarantees, the blockchain can provide solutions to facilitate refunds. This already exists in the case of the reimbursement of airline tickets when flights are late (Cuny, 2017), but it could be generalized to many other situations because blockchains are a less expensive and more reliable option for companies. Strictly monitored by smart contracts, these refund operations – and even promotional offers – may be directly credited to the customer account and could become the norm, thus facilitating a better business relationship.

As regards recommendation systems, Frey et al. (2016) have shown that it is possible to track clients' identities and reputations using certified data from the blockchain, as is the case with the Uziit application, a software that stores reviews and recommendations in a blockchain. In this context, there are strong indications that all review platforms, in the hotel and restaurant industry, for example, will be transformed to take into account only those reviews attributed by the blockchain after verifying the existence of an invoice (hash number) from the establishment. Similarly, it would be possible to use smart contracts to negotiate lower prices in real time automatically while taking into account seller reputation.

3.1.3. Information flow: Information management

Today, very high volumes of data must be collected, processed, stored and communicated in order to trigger and control the basic physical operations required to satisfy all customer requests. As a result, Information and Communication Technologies play a major role in controlling these physical flows. This is particularly true in the case of the blockchain (Perboli et al., 2018 ; Kshetri, 2018). Indeed, in addition to being searchable, as with the data in any database, the data in a blockchain can also trigger processes via smart contracts. This presents a certain advantage in the processing of information because, on the one hand, only the data accredited by the system is relied on and, on the other hand, these data automatically trigger operations through smart contracts. As a result, we believe that companies will have to modify their ERP to ensure that the entire blockchain/ERP link is functional, thus benefiting from a certain degree of automation. Quoting a representative from EY, Mearian (2017) has noted that this is a smaller challenge than it appears because many firms are already using similar tools “for EDI, XML or for analyzing data integration". Models enabling the translation and integration of different EDI or XML messages into a blockchain now exist (Li et al., 2017 ; Fiaidhi et al., 2018). As O'Leary (2017) points out, an alternative to adopting EDI models in order to recover blockchain data is to modify the ERP. Figure 4 below shows the integration of a blockchain across the different layers of an ERP – order, delivery order, billing, payment – with each step marked by an authentication of the acts in a blockchain, thanks to the cryptographic-signatures principle. The blockchain data-set represents a layer underlying the ERP database. These management software systems may therefore shift away from a centralized and relational database toward an automated and transactional database. Moreover, the automated token payment system[4] within an inter-organizational network may accelerate payments while minimizing risks and

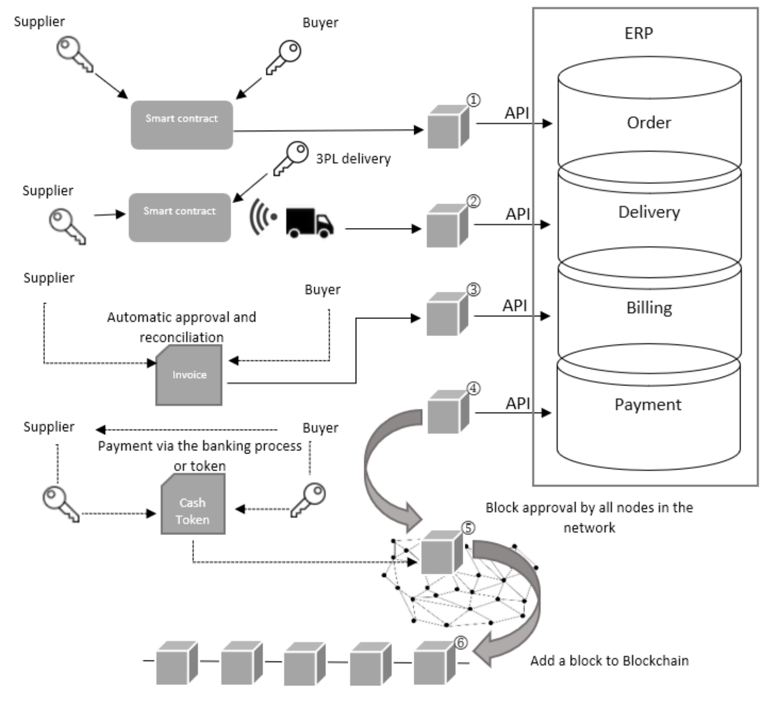

Figure 5: Adaptation of blockchain to ERP. Source: Authors (based on an adaptation of Hoffmann et al. 2018)

[4] *A token is a digital asset issued and exchangeable on a blockchain (definition of blockchain France).*

thus significantly decrease the working capital requirement (WCR) of all partners in the supply chain.

3.1.4. Financial resources: Stronger contract-management mechanisms and improving the WCR

The question that arises is: how does logistics management influence the financial results of a company? The identification of the logistical processes to be outsourced and of their management by a trusted third party, the Logistics Service Provider (LSP), in order to increase a company's efficiency and improve customer satisfaction, requires the implementation of specific contractual mechanisms to avoid the occurrence of malfunctions which may degrade the service that the customer expects. More precisely, the relationships that a firm builds with the different actors in its supply chain give rise to a contract that frequently requires each party to commit to a lasting relationship. This is particularly true in the case of relationships initiated with LSPs. Indeed, the LSP has become a key player in the development, organization and daily monitoring of logistics chains; an LSP is referred to as a Fourth Party Logistics (4PL) when it is capable of supporting the strategy of actors in the supply chain, when it is competent in terms of information systems and when it shows expertise in initiating and building a network of logistics subcontractors for specific requests (Fulconis et al., 2017 ; Wagner and Sutter, 2012 ; Wallenburg and Lukassen, 2011 ; Fabbe-Costes et al., 2008). However, the management of such actors has become inevitable and customers often perceive this management as a difficult process because the two protagonists do not possess the same information during the establishment and realization phases of the contract. As a result, information asymmetry plays a major role in the construction of the relationship which is likely to be marked by mistrust because of the information mastered by each of the two contractors (Roveillo et al., 2012 ; Fulconis and Roveillo, 2017).

Here again, the blockchain may be able to provide solutions. Rico Polim et al. (2017) have shown that it is possible to obtain a good level of transparency with blockchain when awarding contracts or negotiating supply contracts. In such a system, "*retailers post their service needs and prove their intent to enter into an agreement by showing fund source(s) to procure services from 3PL providers who then respond to retailers' enquiry (pricing, performance measure, etc.) in a decentralized and transparent manner. Other retailers and 3PL providers are aware that a transaction has been done, promoting rational pricing for the* *network. We eliminate the broker (administration) fee by hosting such a network. Without having to meet physically, 3PLs have secured orders without the assistance of a 4PL"* (Rico Polim et al., 2017). It is, therefore, perfectly legitimate to question the future of 4PLs within a very broad adoption process of the blockchain by 3PLs. Indeed, such a technology facilitates the encounter between the actors, irrespective of whether they are shippers, logistics providers or carriers, and thus reduces questions of trust, or shifts them to the support technology that is used.

Second, the relationship between the operational performance of the supply chain and the financial stakes involved calls for reflection on the financing of stocks, orders, etc. To reduce their cash cycles, companies use banking products to meet their working capital needs. However, these products are expensive and require numerous administrative documents and several guarantees relative to the origin of funds to combat money-laundering. In this context, the blockchain improves the Know Your Customer (KYC) process, lowers processing costs through a certain level of automation associated with consensus algorithms and improves the transparency of financial transactions (Cermeño, 2016 ; Casey et al., 2018). The securitization of financial operations related to the supply chain, in order to optimize working capital, is an area in which the application of the blockchain could have a great impact (Hofmann et al., 2018). Ultimately, the blockchain may allow the emergence of new types of securitization platforms that could facilitate payments and the authentication of documents.

3.1.5. Requests and forecasts: Improved inventory management and logistics performance

The management of logistics chains must be reflected upon in advance. The greatest challenge is to be able to meet an increasingly diversified demand within a short period of time and with minimum stocks. Reducing stocks therefore helps to improve companies' results (Jones and Womack, 2012). We believe that the blockchain may be used for this purpose, as Madhwal and Panfilov (2017) have shown, using a theoretical demonstration applied to the construction of airliners.

These authors have also shown the effectiveness of the blockchain in the management of spare parts in the field of aviation. "*Assembly ledger will keep the record of all the new products generated at each level, which would be integrated with transaction ledger [sic] that will show the transacting details among the individual members. This whole network could*

also work as inventory registry for individual companies along with details of the products, which will show the production details." (Madhwal and Panfilov, 2017).
Although their studies do not explicitly specify how the forecast data for replenishment is shared, there is actually a fine line between a vendor managed inventory and collaborative planning forecasting replenishment.
These systems currently rely on the acquisition of signals sent by numerous sensors and make the whole rather expensive. However, this must be seen in the light of the commodity value of the stock that one is interested in (for this reason, luxury goods are priority targets for this application of the blockchain).

In conclusion, and on the basis of these different reflections, we propose the model below (Figure 5) to describe the various flows in a supply chain, according to the approach proposed by Mentzer et al. (2001).

Figure 6: Application of the blockchain to the various flows in a supply chain (adaptation of the Mentzer schema, Source: Authors)

3.2. Application of the blockchain and improvement of intra- and inter-company coordination

Let us now turn to the entire supply chain and the associated inter- and intra-organizational issues. Indeed, the model developed by Mentzer et al. underscores that one of the founding principles of SCM is that the performance of the supply chain requires the coordination – an "interface management" – of all the actors involved in the management of various flows. Therefore, while the management of all information, and its circulation, storage and processing, is key to a successful supply chain, a set of principles must be adopted in order to promote the management of the interfaces (inter-functional decompartmentalization undertaken internally and forms of cooperation through external networks): behavioral integration, mutual sharing of information, cooperation, etc. The blockchain may provide a source of data to facilitate the implementation of the main inter-company collaboration methods, i.e., vendor managed inventory (VMI) or collaborative planning, forecasting and replenishment (CPFR). According to Lavastre and Ageron (2007): "*The flexibility of inter-organizational tools is also reflected in their ease of operationalization: a simple extraction from a company's database, sent by e-mail to the company's partner, may constitute either VMI or CPFR depending on the information provided. The technique should not act as an obstacle to this exchange of information, but rather the triggering of actions must be a deliberate choice of actors and organizations*." The blockchain can become a means of structuring these exchanges and can serve as an extended business model. Given that the blockchain is a distributed ledger, its data is the result of certified transactions between actors in the same supply chain. From this perspective, it is therefore a solution that allows a complete and total collaboration between the actors, as shown in Figure 6 below.

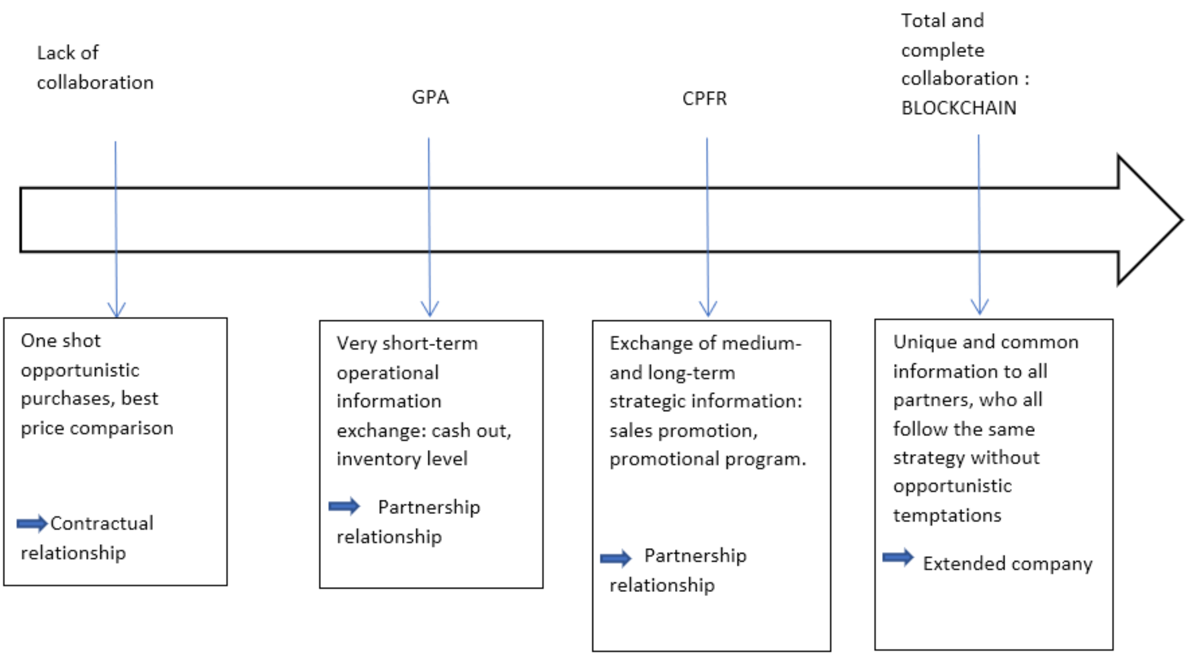

Figure 7: VMI, CPFR and blockchain: different levels of the same continuum (adapted from Lavastre and Ageron 2007).

Certain blockchain systems make it possible, through the adaptation of the algorithm, for the entire structure to allow each member of the platform to benefit from renewing the contracts initiated.

By making it impossible for participants to cheat, it prevents all opportunist attempts within a space of relative confidence, referred to as a consortium, whose ultimate interest may be cost reduction because of reduced transaction costs. According to several authors, this new relationship mode goes beyond simply sharing data; as such, the blockchain may present new institutional technology (Davidson et al., 2018). It thus provides a new space for exchange within which companies are interconnected. This may be represented by the diagram below (Figure 7), adapted from Mentzer et al. (2001).

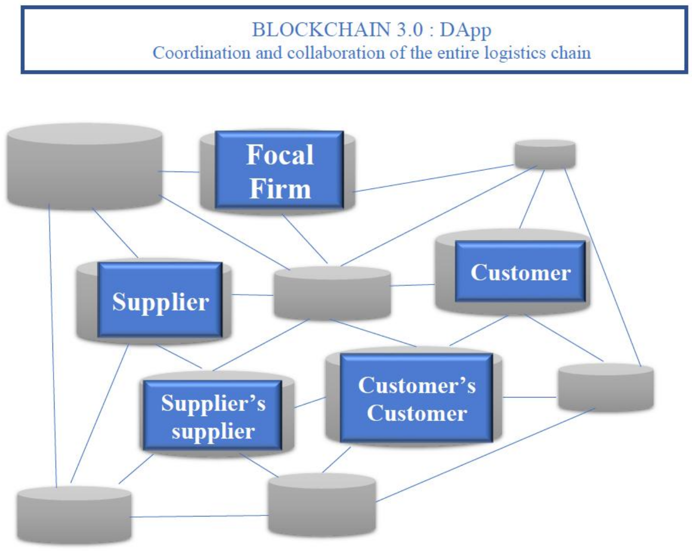

Figure 8: Blockchain 3.0: towards a new space for exchange, Source: Authors

If the Blockchain allows the focal firm control of all information flows for more efficient management of its supply chain it would particularly favor the development of consortia made up of business cooperation sharing standards, data, technical protocols,. These Business Ecosystems would likely become means of structuring exchange and a model of " extended enterprise ". They can also be called " business constellation[5] " (Della Chiesa et al., 2018), "catallaxia [6]" or "business platform" [7] (Mearian, 2017; Reillier, Reillier, 2017).

[5] *Alliance constellations are strategic alliances formed by multiple partner firms to "compete against other such groups and against traditional firms"*(Gomes-Casseres, 1996) , (Das, Teng, 2002).
[6] *Catallaxia comes from the ancient Greek verb katallatein, which means "action of exchanging, the act of getting admitted into a community,..." (Lottieri, 1993) a term introduced by Hayek "A catallaxia is thus the kind*

These types of organization could be the major support for managing the supply chain that has become multi-stakeholder ; a tool for vertical cooperation, horizontal cooperation and transversal cooperation

4. Conclusion and avenues for further reflection

The reflection initiated here highlights several ways in which the blockchain may contribute to logistics and SCM at the level of intra-organizational processes, as well as at the level of inter-organizational processes. The blockchain can impact on "product flows", notably by providing a finer traceability made possible by the hashing algorithms. It can also impact on "service flows" by enabling data accreditation which, with time, may lead to the emergence of new referral systems. "Information flows" can also be impacted by the arrival of the blockchain. Indeed, the automation provided by smart contracts grants the data dynamic properties insofar as they become capable of triggering processes. In addition, the mechanisms for managing contracts through the blockchain are stronger. Indeed, it is easier to obtain a good level of transparency when using a blockchain to award contracts or negotiate supply contracts. Moreover, the blockchain must improve inventory management and logistics performance. Lastly, the blockchain is a means through which to structure exchanges and one that allows the creation of an extended enterprise. From this perspective, it requires and encourages the complete and total collaboration of actors. In light of the major developments of this technology and following our reflection, we have been led to rethink the model proposed by Mentzer et al. (Figure 8):

of spontaneous order produced by the market through people complying with legal rules concerning property, damages and contracts. "(Hayek, 2015)

[7] *"…platform businesses as those connecting members of communities and enabling them to transact."(Reillier, Reillier, 2017)*

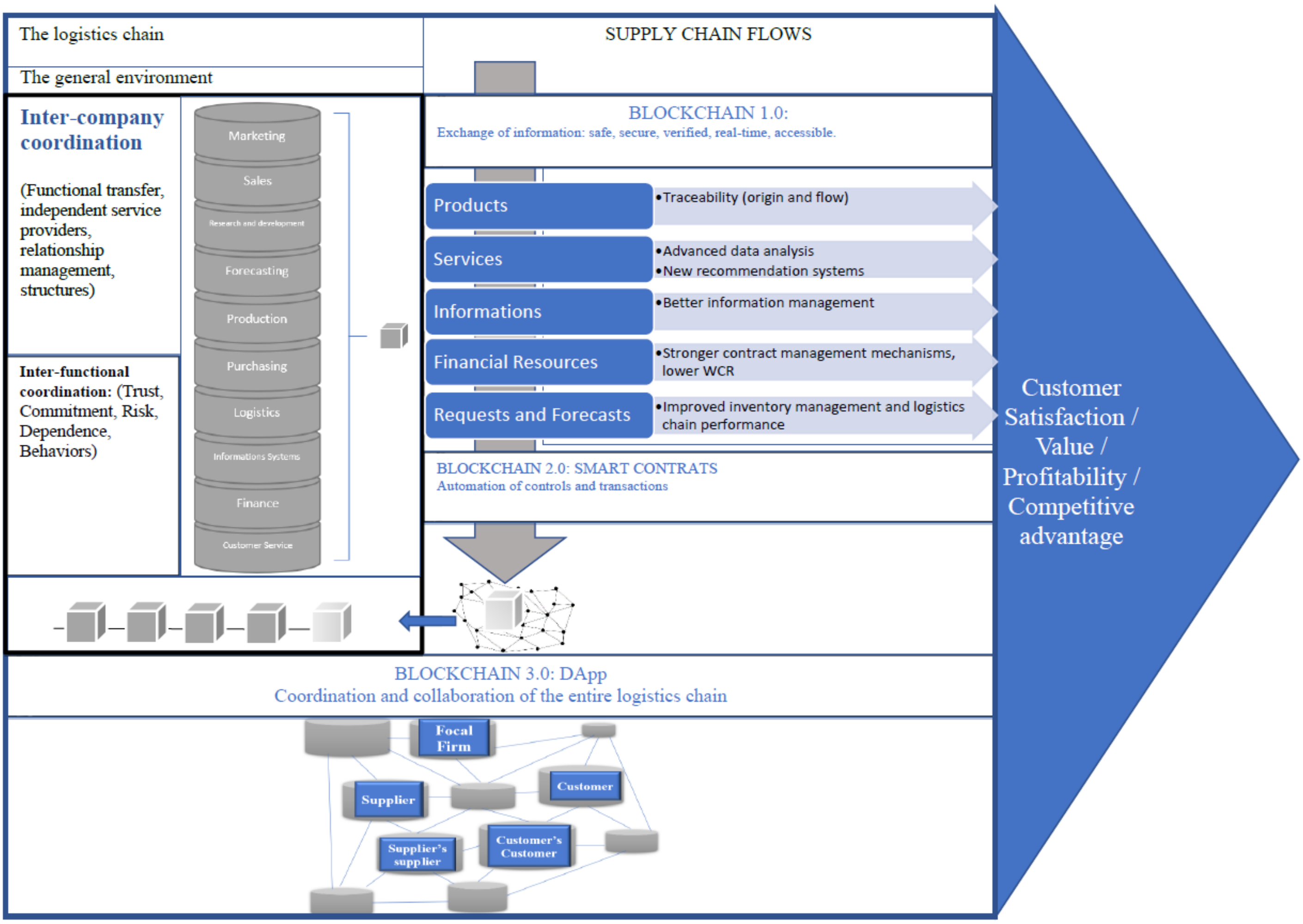

Figure 9: Adaptation of the blockchain to the model proposed by Mentzer et al (2001), source: Authors.

Like the Internet at the end of the 20th century, the blockchain seems to characterize a major innovation for the 21st century. The use of smart contracts and consensus algorithms is a technological innovation. Once the first model (Blockchain 2.0) was adopted by manufacturers, some companies (Carrefour, Nestle, Airbus) shifted to an approach more likely to produce gains (lower transaction costs, improved resource management). This second level of blockchain (Blockchain 3.0), practised within consortium blockchains and inter-organizational systems, may, for its part, be equated with radical innovation. These new models may lead to a shift from classical governance models to more balanced and cooperative models. Christensen suggests that a new business model leads to the emergence of new actors (Jouini, Silberzahn, 2016). In this sense, new blockchain platforms may represent new marketplaces and also introduce new performance criteria. On the economic front in particular, several authors have shown that blockchains are new institutional technologies (Davidson et al., 2018) that lead to lower transaction costs. However, as

Treiblmaier (2018) has shown, the academic research on SCM to date is still in its infancy stage. There is therefore a need to develop further empirical studies on this subject.

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